

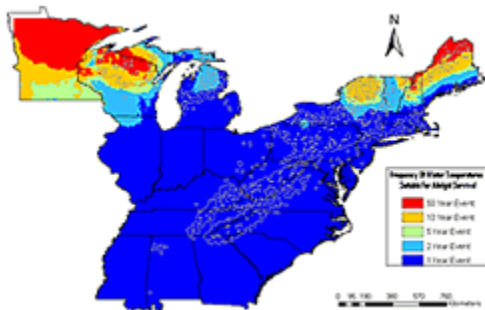
Landscape Estimates of Hemlock Woolly Adelgid Survival and Potential Range

Research Issue



The hemlock woolly adelgid (*Adelges tsugae*) (HWA) seriously threatens both eastern and Carolina hemlock (*Tsuga canadensis* and *T. caroliniana*, respectively) in the eastern United States. However, not all hemlock on the landscape are equally impacted by the adelgid, suggesting the severity of the risk posed by the adelgid varies geographically. Work is underway to identify the landscape factors that impact adelgid growth and survival. Currently, it is known that the adelgid has a limited tolerance for the cold. Research on HWA [origin and genetics](#) has shown that the strain found in the eastern United States was introduced from a moderate climatic region in Japan, suggesting this strain may not be cold hardy (the data also highlight the importance of avoiding the introduction of additional strains of the adelgid, some of which may have a higher tolerance for lower temperatures). These observations, along with landscape surveys of adelgid survival, are a starting point for estimating the risk posed by the adelgid to the eastern United States and for seeking and identifying other landscape variables, such as stand structure, topography, and dispersal corridors that may influence the risk posed by the HWA across the landscape.

Our Research



In the eastern United States, the adelgid causes increased mortality among both eastern and Carolina hemlocks (*Tsuga canadensis* Car. and *T. caroliniana* Engelm., respectively); however, this increased mortality is influenced by how far north or south the hemlock are. Recent surveys of *A. tsugae* mortality across the infested latitudinal gradient of the eastern United States show there is a significant relationship between latitude, and more importantly, minimum winter temperatures, and winter survival at the landscape scale. The strength and nature of this relationship, however, is known to vary through time, with absolute minimum winter

temperatures explaining almost one-half of the tree-level variance in some years and as little as 9 percent in others. Work is underway to gather additional data, identify other abiotic sources of adelgid mortality on the landscape, and integrate these using geospatial analyses to both estimate current risk and place these data in the context of climate variability.

Using landscape estimates of minimum winter temperature and data on adelgid survival, we have shown two simple methods of estimating landscape-scale adelgid survival rates (**See maps**). Both methods suggest much of the range of *T. canadensis* in the eastern United States and the entire range of *T. caroliniana* fall in areas where winter temperatures will not impose critical limits on *A. tsugae* populations.

Expected Outcomes

- Provide a quantitative basis for evaluating landscape risk posed by the HWA
- provide a framework for prioritizing management needs, and
- Identify areas where management may be facilitated by intrinsic landscape characteristics

Research Results

Previous work has suggested low temperatures may limit northward spread of the adelgid. Using recent surveys of *A. tsugae* mortality across the infested latitudinal gradient of the eastern United States, we show there is a significant positive relationship between minimum winter temperatures and winter survival at the landscape scale. The strength and nature of this relationship, however, varies through time, with absolute minimum winter temperatures explaining almost one half of the tree-level variance in survival in the spring of 2004 but only 9% in 2003. Post hoc analyses of the data suggest the explanatory power of temperature can be improved in ongoing studies by examining seasonal temperature profiles. Previous studies have also suggested adelgid survival may be density dependent, and although these data support this observation, contemporary density is a poor predictor of adelgid survival at the landscape scale. Using landscape estimates of minimum winter temperature, we show two simple methods of estimating landscape-scale adelgid survival rates. Both methods suggest much of the range of *T. canadensis* in the eastern United States, and the entire range of *T. caroliniana* falls in areas where winter temperatures will not impose critical limits on *A. tsugae* populations.

Trotter III, R. T.; Shields, K. S. 2009. [Variation in winter survival of the invasive hemlock woolly adelgid \(Hemiptera: Adelgidae\) across the eastern United States](#). *Environmental Entomology*. 38: 577.

Research Participants

Principal Investigator

- [R. Talbot Trotter III](#), Research Ecologist U.S. Forest Service, Northern Research Station

Research Partners

- Kathleen S. Shields, Research Entomologist (retired), U.S. Forest Service, Northern Research Station
- Scott Costa, Research Assistant Professor, University of Vermont, Department of Plant and Soil Science
- Mark Whitmore, Extension Associate, Cornell University, Department of Natural Resources

Last Modified: 07/12/2010